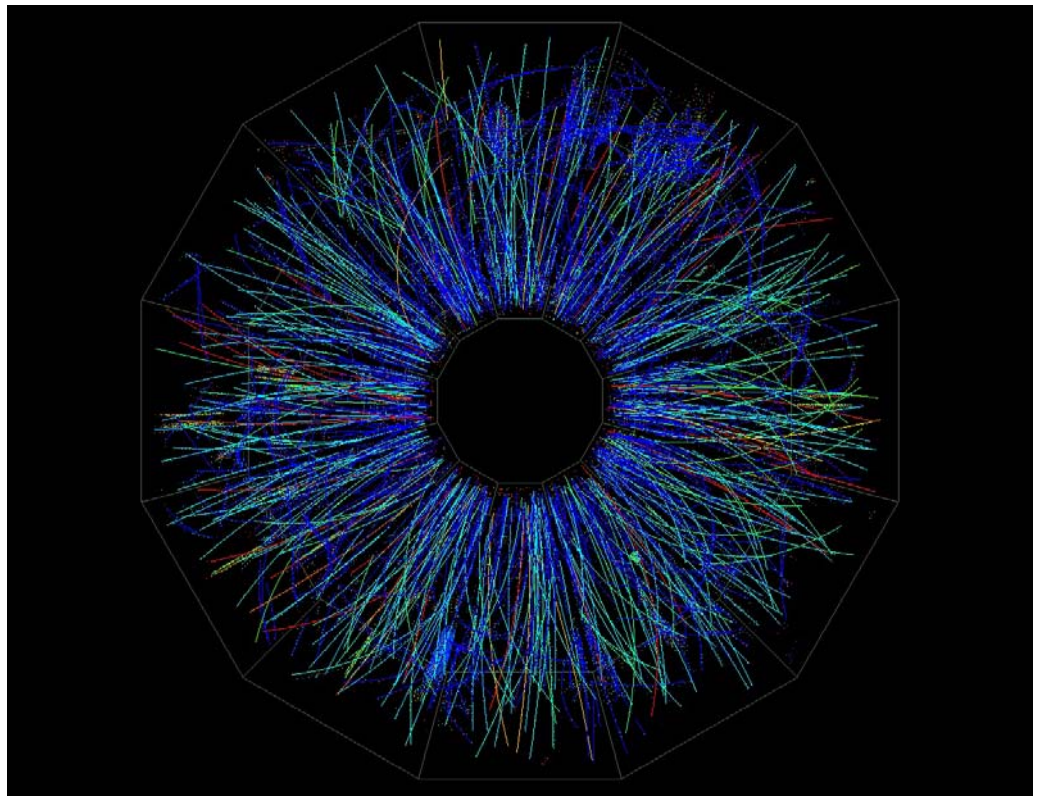
STAR Annual Safety Review

W.B. Christie, BNL

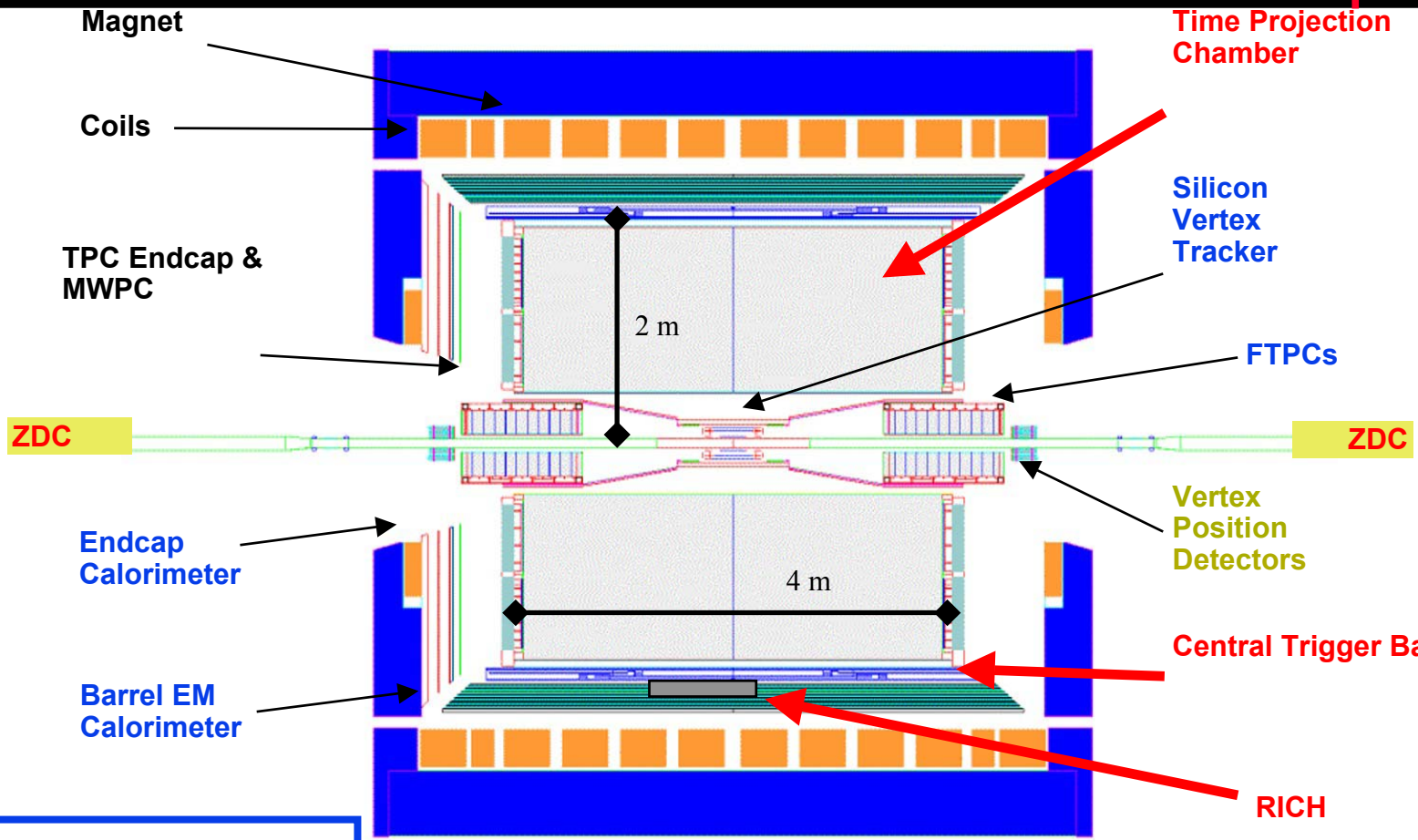
April 4, 2001.

Outline

- **The STAR Detector for Year 2**
- **Plan for Operations/shifts**
- **Walkthrough of Sub Systems**
- **Interlocks**
- **Procedures**
- **Summary**

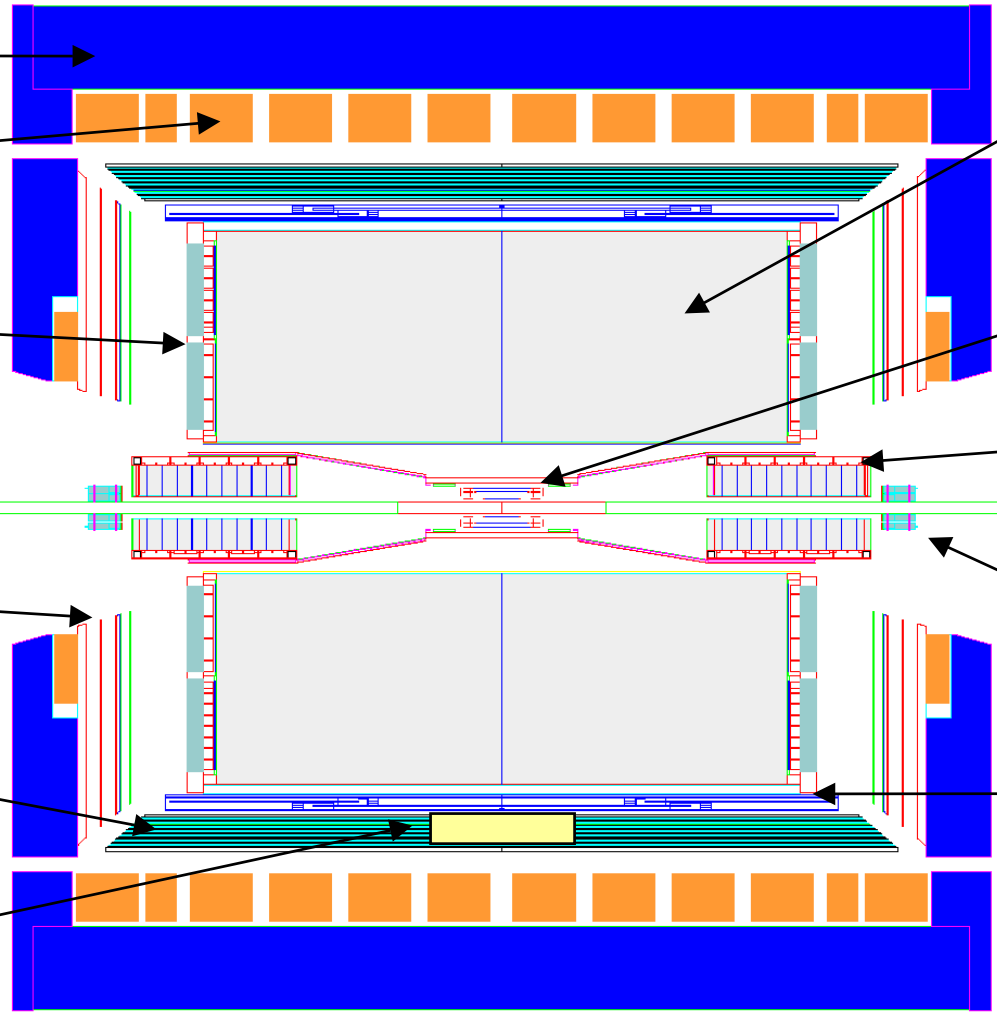


The STAR Detector for Year 2



red → year1 detectors

The STAR Detector (year-by-year)



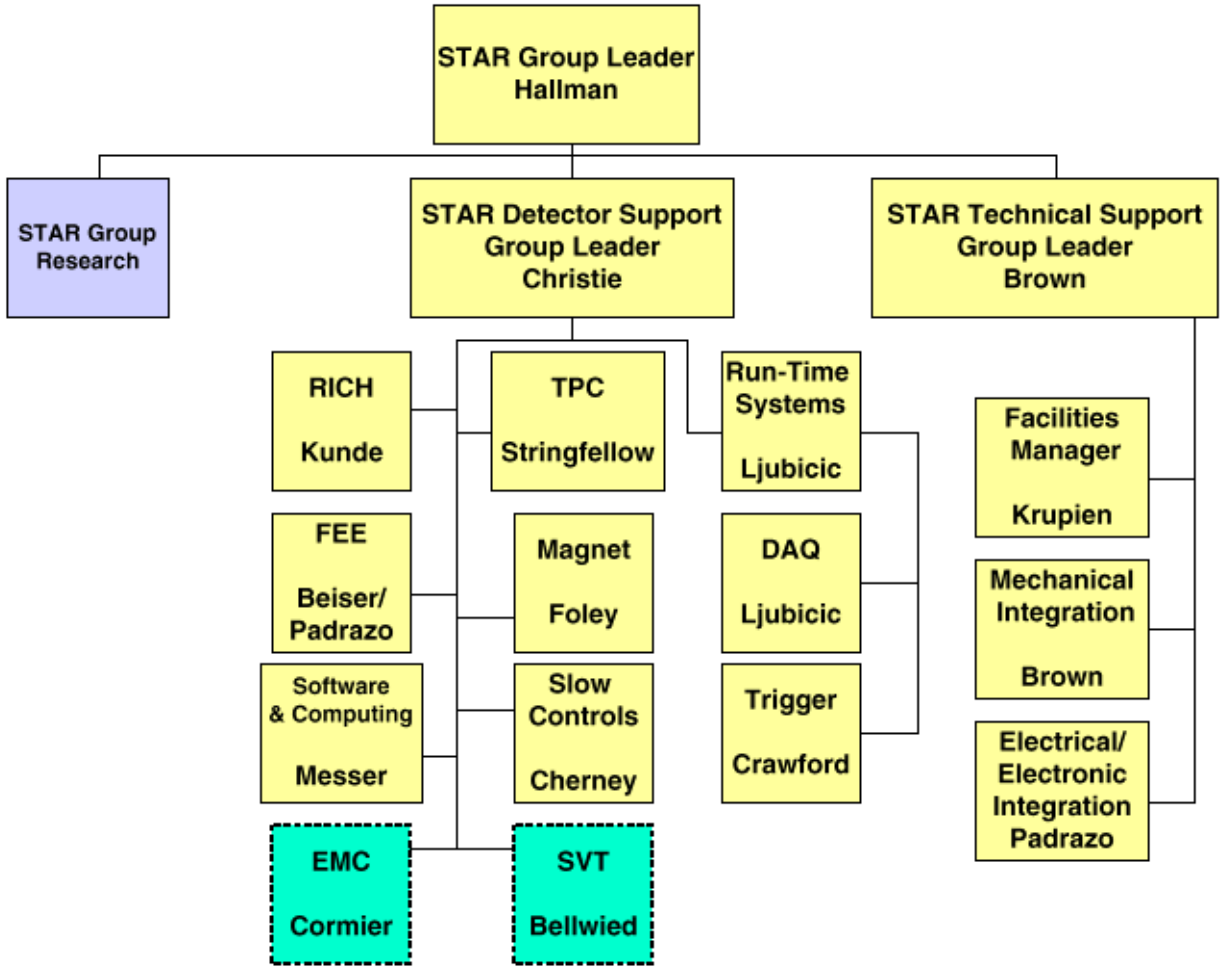
Magnet
Coils
TPC Endcap & MWPC
ZCal
Endcap Calorimeter
Barrel EM Calorimeter
RICH
Time Projection Chamber
Silicon Vertex Tracker *
FTPCs (1 + 1)
ZCal
Vertex Position Detectors
Central Trigger Barrel + TOF patch
* yr.1 SVT ladder

New Detectors for Year 2:

- Silicon Vertex Tracker (SVT)
- Forward Time Projection Chambers (FTPCs)
- Patch Time of Flight (pTOF) & VPDs
- 24 Modules of Barrel EMC & Shower Maximum Detectors (SMDs)
- Forward Pion Detector (FPD)

- 1st year, 2nd year, year-by-year until 2003, installation in 2003

Plan for Operations and Shifts



Plan for Operations and Shifts

- STAR has had two "Critique" (aka Self-Assessment) meetings for Operations
  - October 24-25 2000 & April 3, 2001

- New Shift Staffing Plan
  - Shift Leader
  - Detector Operator
  - Run Control/Trigger/Online QA/Online Log
  - Shift person
    - Shift term will be 8 days (one day of overlap)
    - Shift crew will be stable (i.e. same set of people) for duration of shift

- Shift Leader QA
  - Committee appointed to review and evaluate shift leaders
  - First meeting of this group (phone conference) is today, April 4th
- Detector Operator "Hands On" school planned for late May, early June period

Sub Systems - Time Projection Chamber (TPC)

1. Configuration: Full TPC used
Additional detector: small MWPC gain chamber mounted inside the TPC return gas manifold (west side at 12:00). Chamber has a 100 microcurie Fe55 source inside. HV is interlocked the same as the TPC.

2. Voltages:
TPC inner sectors 1170 V
TPC outer sectors 1390 V
Gain Chamber 1400 V
TPC Cathode Up to 35 kV (nominal 31.0)
Gated grid 130 V
FEE & RDO power +/- 8V
Two lasers with no exposed beams

3. Gas system:
Main TPC gas is P10 (10% Methane, 90% Ar)
Purge flow rate = 120 lpm for a total of 3 volume exchanges (TPC volume = 50,000 l)

Normal recirculating flow = 560 lpm with 14 lpm vented out the stack (stack located on the east wall of the STAR assembly building with the vent exit above the level of the berm retaining wall.)

Insulating gap gas is N2 - flow rate is 10 lpm out the vent stack.

N2 is also used in various places in the gas system, laser system and water system - total flow ~ 50 lpm vented to the room.

4. Water cooling - the TPC FEE & RDO are cooled by a closed loop water cooling system. Heat exchange is to the STAR MCW. Total volume is ~700 gallons and flow rate is 320 GPM. The system is located in the second floor utility room at STAR. No water is released to the environment.

5. Safety interlock: The TPC has an Allen-Bradley SLC interlock system. The main system is located in the gas mixing room, with a remote slave system located on the second floor south platform. The SLC is used for equipment protection, and is closely linked to the STAR SGIS. The TPC system provides interlocks and alarms for the TPC HV and LV. Changes for this year will incorporate new inputs from the SVT leak detection and data from the TPC water system.

6. No new procedures.

Essentially No Changes from Last Year.

Sub Systems - RICH

Complete RICH will be used.

Voltages: +- 4 V for FEE, 2100V for anodes, 300V for collector.

Gases:

Gas system:

Methane 30 l/hr, vented through vent stack on SE corner of assembly building

N2 for Safety Box 90 l/hr, vented into atmosphere through xx

Liquid system: Ar: supply press 3000mbar system press +2 mbar
inlet flow 15 l/hr vented 15 l/hr NW AH vent
N2: supply press 120 mbar system press 100mb
inlet flow 0 l/hr no vent

Radiator: C6F14, main volume <100 l, pressure 3000 mbar
flow rate 0.003l/hr,
distbn <10 l, pressure 75 mbar, no flow
gravity feed.

Refrigerant: C3H8O2 13 l, pressure 0 mbar, no flow
Bubbler: DOW 704 1 l, pressure 0 mbar, no flow

Water to cool back of Safety Box from TPC supply, flow rate 120 gal/hr, Trace Tec monitored by global interlock system for leaks.

Essentially No Changes from Last Year

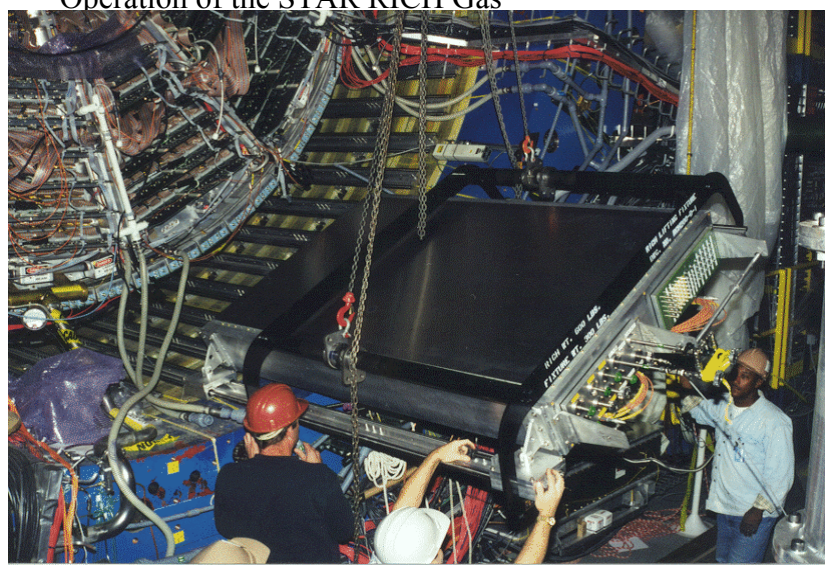
Safety Interlock System:

Allen Bradley PLC-based interlock system for automatic shutoff and purge of CH4, shutoff of voltage to the detector and to the gas control system.
Ar purge for CH4 level in safety box N2 > 20% LEL, 02 and H2O levels beyond limits.
CH4 level in gas room > 18% LEL, and alarms from the global interlock system. Total shutoff of gas flow under overpressure conditions.

Siemens PLC-based control system for liquid system.

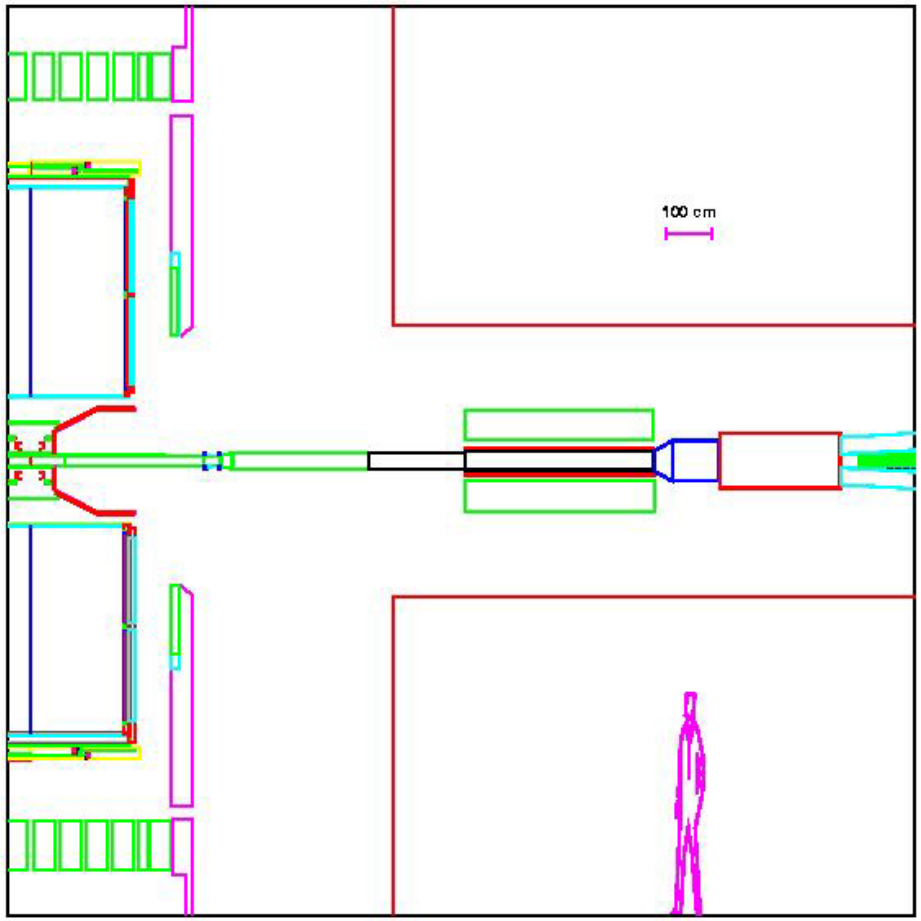
Documents:

STAR Documented Work Procedure SOP-RICH-GAS-01-A Documented Work Procedure for the Startup and Operation of the STAR RICH Gas

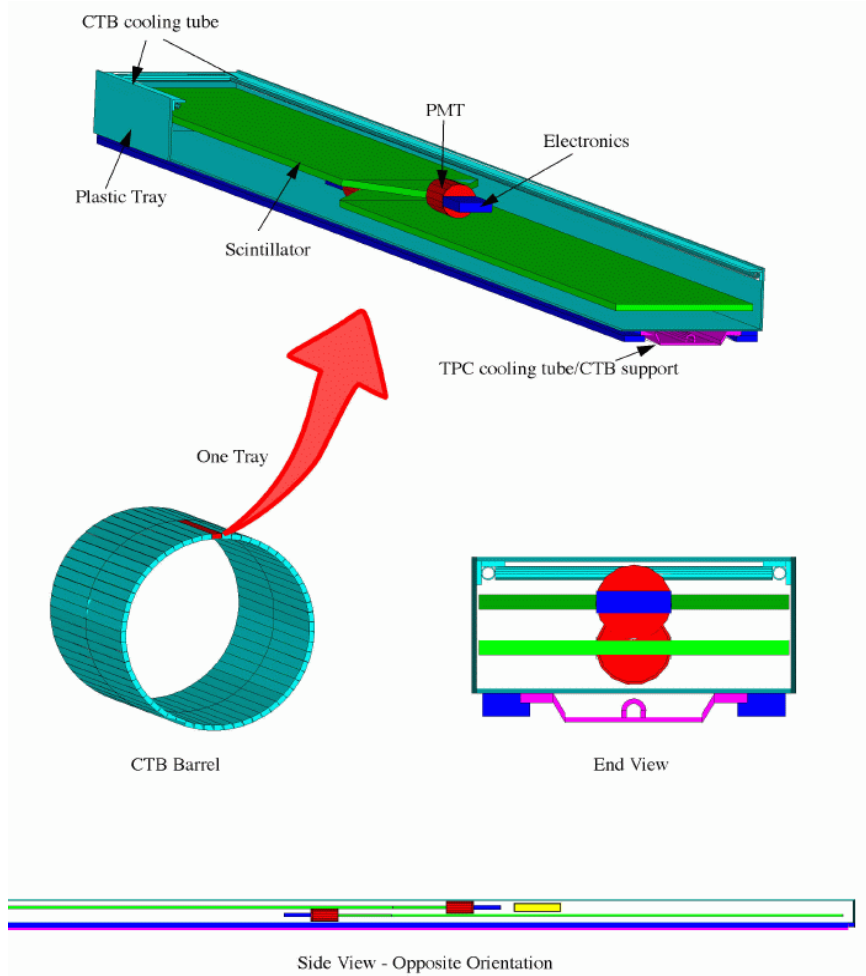


Sub Systems - Trigger

Zero Degree Calorimeters (ZDC) Coincidence.



Central Trigger Barrel (CTB) Summed ADC Threshold.



Essentially No Changes from Last Year

New Sub Systems - Silicon Vertex Tracker (SVT)

1. Configuration: Full SVT used
   (3 barrels = 36 ladders = 216 wafers = 103,680 channels)

2. Voltages:

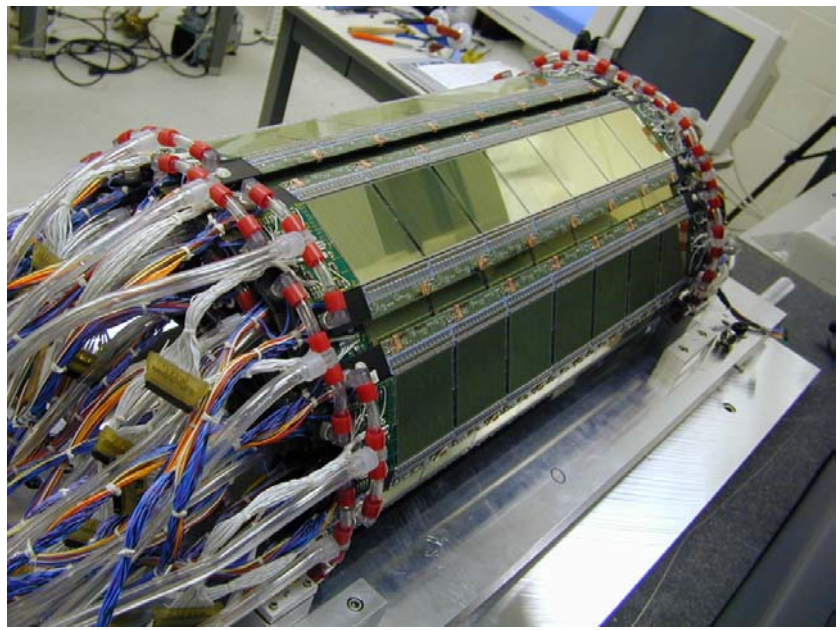
   SVT high voltage 1500 V (fully enclosed, I < 9 mA)
   FEE & RDO power +/- 8V
   calibration voltages < 20V
   Two class TBD lasers with no exposed beams

3. Gas system: no gas system

4. Water cooling:
   a.) the SVT front-end electronics (on-detector) are cooled by an independent closed loop water cooling system. Heat exchange is to the wide angle hall. Total volume is ~45 gallons, the volume of water in the system is 32 gallons. The maximum system pressure is 30 psig, however all elements inside the TPC are below atmospheric pressure. The nominal flow rate is 10.5 gpm at a nominal water temperature of 75 F. The system is located on the first floor of STAR North platform in the Wide Angle Hall. No water is released to the environment.
   b.) the SVT RDO boxes are cooled by the TPC RDO closed loop water cooling system. The nominal flow rate through the RDO boxes is 12-19 gpm.

5. Air cooling:
   a.) the SVT is air-cooled from outside the TPC wheel. An air manifold is mounted to the TPC wheel. The air is pumped into the SVT volume from the East Side and released to the Wide Angle Hall on the West Side. The operating pressure will be less than 0.8 in. H2O (2 mbar). The shut off pressure is 2 in. H2O (5 mbar)

   The nominal temperature is 75 F and the maximum flow rate is 600 cfm (17000 lpm), however we expect much less.



New Sub Systems - Silicon Vertex Tracker (SVT)

5. Safety interlock:

The SVT has a custom-made relay driven interlock system for equipment protection. The main system is located on the STAR south platform (2nd floor). The system is closely linked to the STAR SGIS. The SVT system provides interlocks and alarms for the SVT HV and LV, plus RDO crate overtemperature and the RDO water system flow and temperature. In order to turn on the SVT-LV the following permissions have to be granted:

a.) global (from SGIS) (requires tpc water flow, inner field cage air flow and all other global locks)

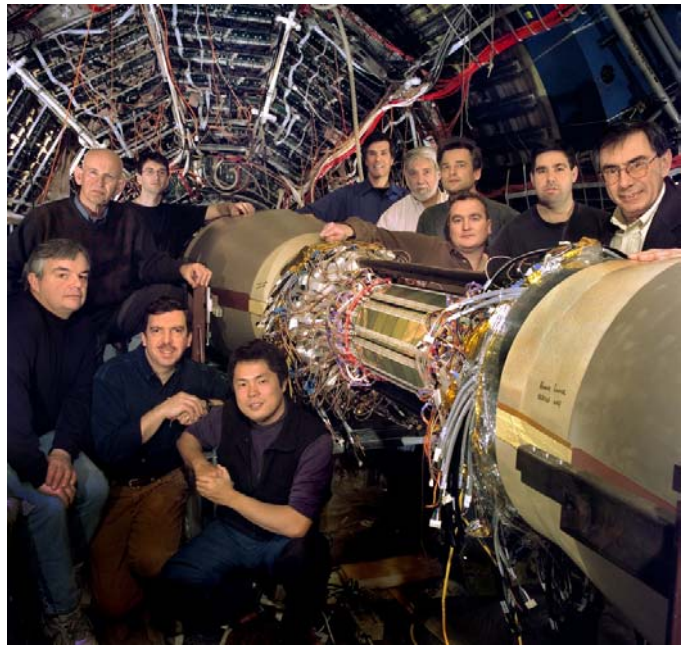
b.) no-leak (from trace-tek via TPC Allen Bradley) (requires no water leaks in any connected system)

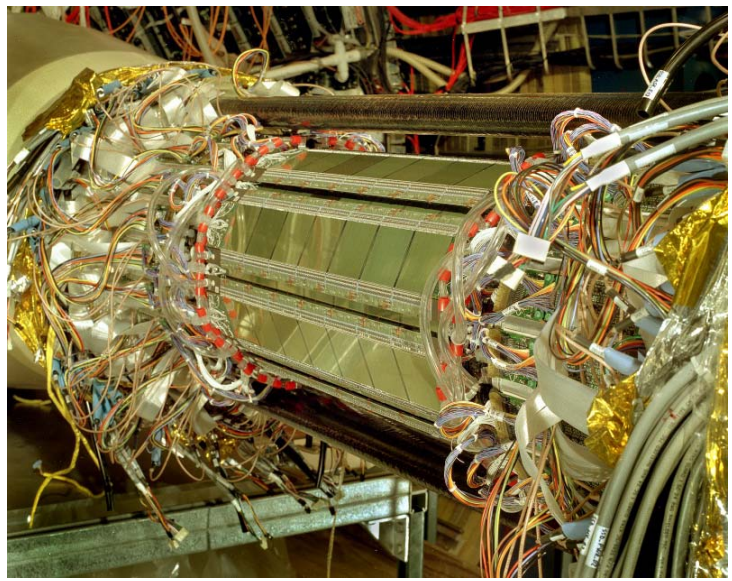
c.) SVT water (from thermal dispersion flow switch located in svt water system) (requires SVT water is flowing)

d.) SVT water temperature (from temperature switch in svt water system) (requires that svt water temperature does not exceed 100 F).

The SVT-HV can only be turned on if the SVT-LV is on.
The SVT leak detection is also incorporated into the STAR SGIS.
In case of a leak the SVT water pump will shut off.

6. No new procedures.





New Sub Systems - Forward TPCs (FTPC)

1. Configuration:
   i) Both FTPCs in the same configuration as for the previous tests.
   ii) Later (May/June) 2 drift velocity monitors (DVM) will be installed into the gas system
   iii) 2 TPC lasers used; no open beam

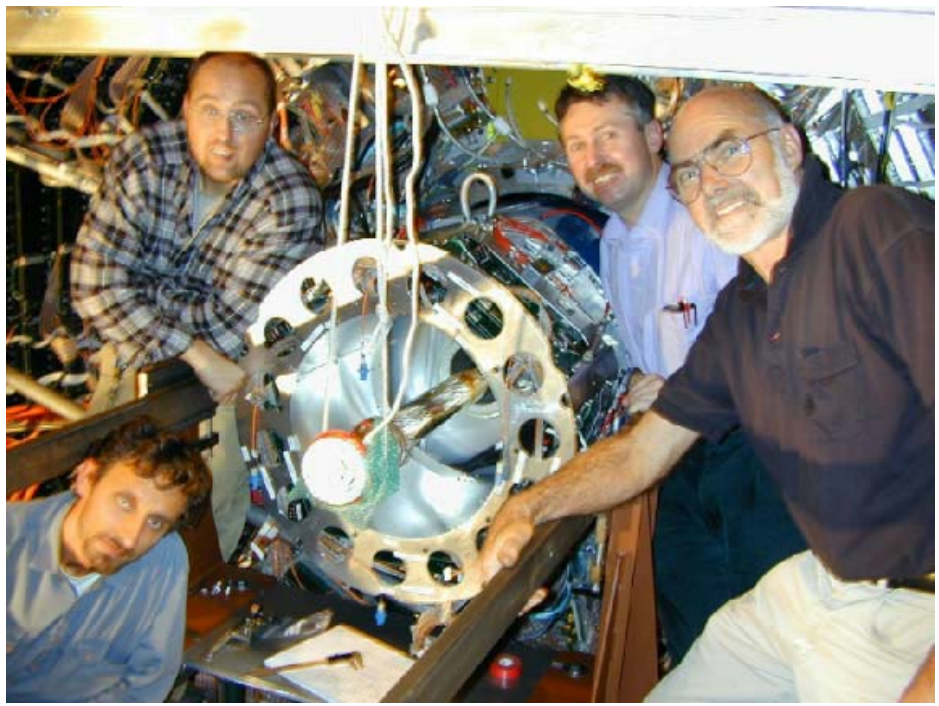
2. Voltages:
   Anode voltage (readout chambers) :1750+/-50 V
   Anode voltage (DVM) : 1200+/-50 V
   Drift voltage (FTPC) : 12.5+/-.5 kV
   Drift voltage (DVM) : 6 kV
   Low voltage (FEE + RDO) : +/-8 V
   Gating grid voltage : 180 V

3. Gas system:
   Gas mixture: Ar/CO2 (50/50)
   Purge flow: ca. 200 l/h and chamber
   Operation flow: 50 - 100 l/h and chamber (in purge mode, will be higher in circulation mode)
   Location: Gas mixing room
   Exhaust to gas mixing room

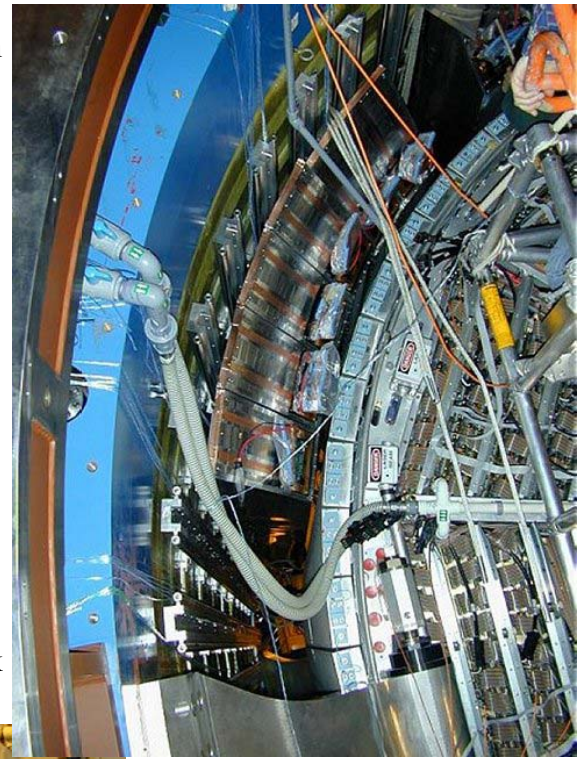
4. Water cooling:
   Water cooling for FEE and RDO boards
   Supply system is closed circuit at low pressure (leakless) with heat exchanger to MCW
   Total water volume: < 10 gallons
   Flow: < 1.0 g/min
   Supply system is located on 1. level on North platform
   No water release to environment

5. Safety interlock:
   The FTPC interlock system is closely linked to the SGIS (Star General Interlock System) and the TPC interlock. TPC interlock outputs are fed into the FTPC system and are processed through a relay ensemble to control LV and HV. LV are also interlocked to the FTPC cooling system.
   Under development, and expected to be operative before the run starts, are the HV interlock that inputs from the FTPC gas system and the cooling system interlock connected to the STAR water detection system.

5. Detector specific procedures are in preparation



New Sub System - Barrel EMC



1. Configuration: 11 and two ½ EMC modules instrumented for the start of RHIC year 2001 run period. The modules are: ½ of 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58 and ½ of 59 (West face of STAR).

2. EMC modules to be instrumented during the RHIC 2001 run period: 9 and two ½. The modules are: ½ of 59, 60, 1, 2, 3, 4, 5, 6, 7, 8 and ½ of 9 (West face of STAR).

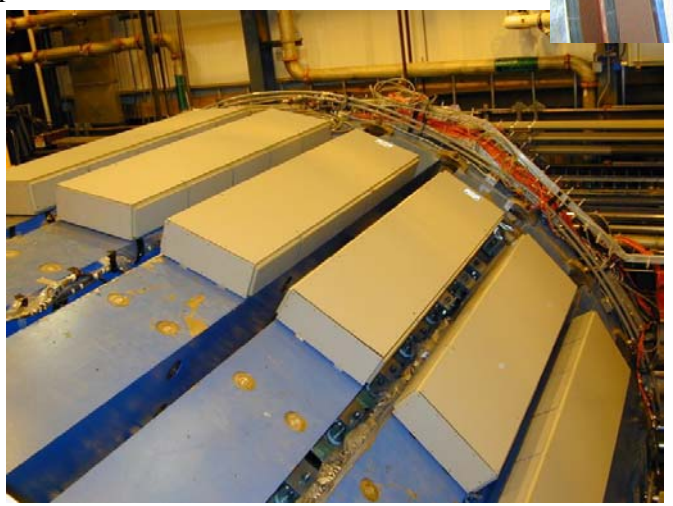
3. Voltages:

EMC barrel PMT:	1470V fully enclosed and less than 10ma.
SMD wires:	1430V operating, 1500V maximum fully enclosed and less than 10ma.
FEE & RDO power:	+/- 8V max.

No lasers.

4. Water cooling: The SMD FEE electronics are cooled by a closed loop water cooling system.

5. Safety interlock: The EMC has a relay based interlock system. A feed from the TPC interlock system includes water leak detection and HV and LV permissives from STAR.
EMC local interlocks include:
SMD water system flow and temperature
Crate power supply overvoltage and overcurrent.
Crate overtemperature.
SMD FEE overtemperature.



New Sub System - Barrel SMD

Configuration: 24 modules and conventional system for them installed (out of 120 for full system).
Notes: SMD Modules require High Voltage, Gas Flow, Water Cooling and all grounds are electrically isolated from the EMC and each other.

Voltages:
High Voltage supplied by Lecroy 1454 Crate located at 12 o'clock on BL1W.
SMD HV - 1430 V

Gas System:
Gas Bottles/Initial Supply Manifold located immediately outside door of gas utility room in STAR hall. Stepdown regulator located on third floor south platform of STAR Detector. Bubbler arrays located at 10 o'clock/2 o'clock West positions on backleg steel.

SMD Gas is 90%Argon-10%Carbon Dioxide at low flow and atm. pressure.
Maximum Supply Pressure to Modules is 9 PSI

Pressure inside the SMD module -
12 mm H2O above atmospheric at nominal gas flow.
Total Gas Volume ~ 120,000 cm**3

Modules are ganged together in pairs, i.e. 24 modules = 12 pairs
Nominal Flow Rate - 10 cm**3/min /module
Total Nominal Flow rate - 240 cm**3/ min

Gas is low flow, low pressure and non-hazardous.
Accidental overpressure of supply line (>50 PSI) vented outside building.
Gas is vented outside magnet thru system of bubblers into hall.
Gas Flow is monitored by remote TV cameras on array of bubblers

Water Cooling:
The SMD FEE are cooled by a closed loop water cooling system.
Heat exchange is to the STAR MCW.
Total volume is ~ 1 liter, total flow rate ~ 100 cc/s.
Cooling water circuit supply/return rings on West end of Magnet.
Routing to detectors through plastic hoses with separate shutoff valves at 6 places around the ring on the West end of the magnet.
Water may be shut off at manifold on NorthWest floor level of STAR detector.

No water is released to the environment.

Supply Pressure = 110-120 PSI
Return Pressure = 23 PSI

All circuits pressure rated to 245 PSI @ 100F
Installed heat-exchangers tested to 150 PSI to UCLA, all circuits tested being installed to 110-120 PSI.

10. Safety Interlocks:

High Voltage has hardware interlocks similar to the SVT subsystem.

Front End Electronics has temperature-sensors to shut off low voltage in case of loss of chilled water.

Gas system has a vent valve outside of the building in case of accidental overpressure of the supply line.

New Sub Systems - Patch TOF (pTOF) & VPDs

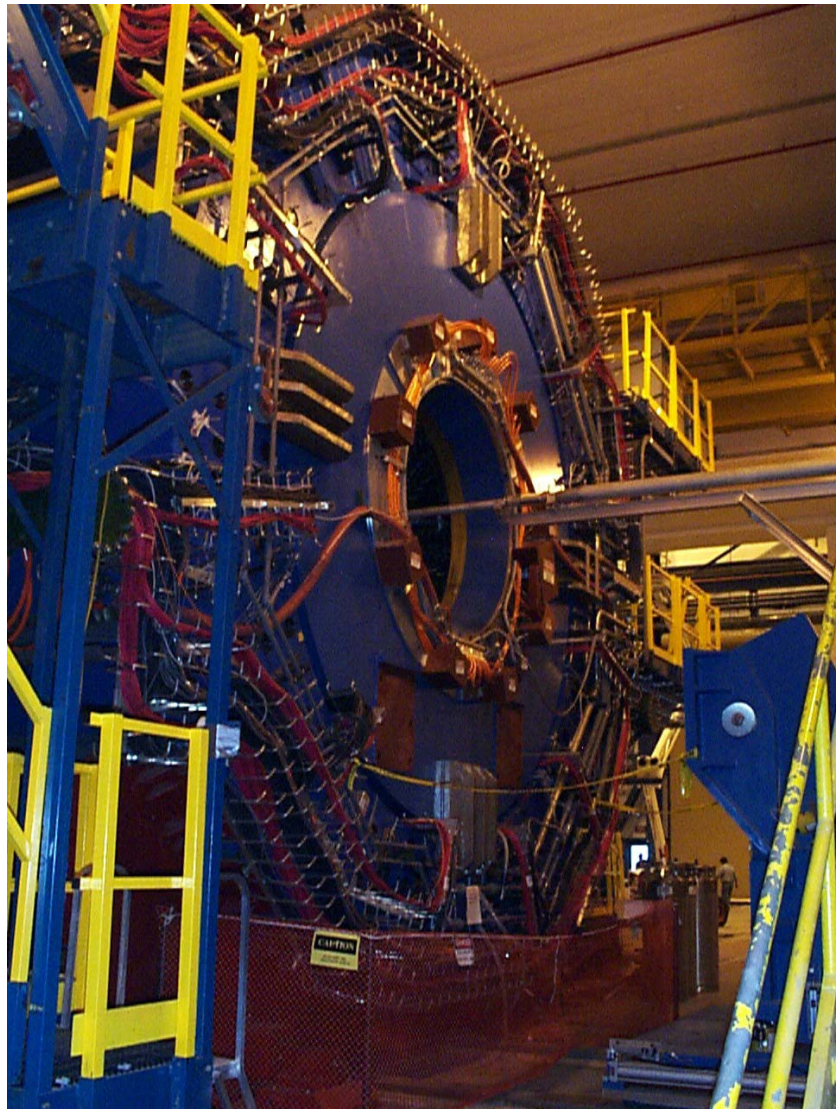
Time of Flight Patch (TOFp)

- One tray which replaces a CTB tray
- Contains 45 scintillator slats and PMTs
- Water cooling

Prototype Vertex Position Detector (PVPD)

- Each pVPD contains three PMTs
- Located on each side of STAR, on beampipe support

pTOF Tray had an Installation Safety Review/ORR on February 16, 2001.



New Sub System - Forward Pion Detector (FPD)

Voltages:
High voltage is supplied to the FPD photomultiplier tubes (PMT).

Pb-glass PMT (48 total): 1300-1500 V, 0.25 W
for each voltage divider
prototype EMC `tower' PMT (12 total): ~1000 V
generated by Cockcroft-Walton bases made by HV-SYS

multi-anode PMT (12 total): ~1000 V, 0.25 W
for each voltage divider

Gases: NONE

Liquids: NONE

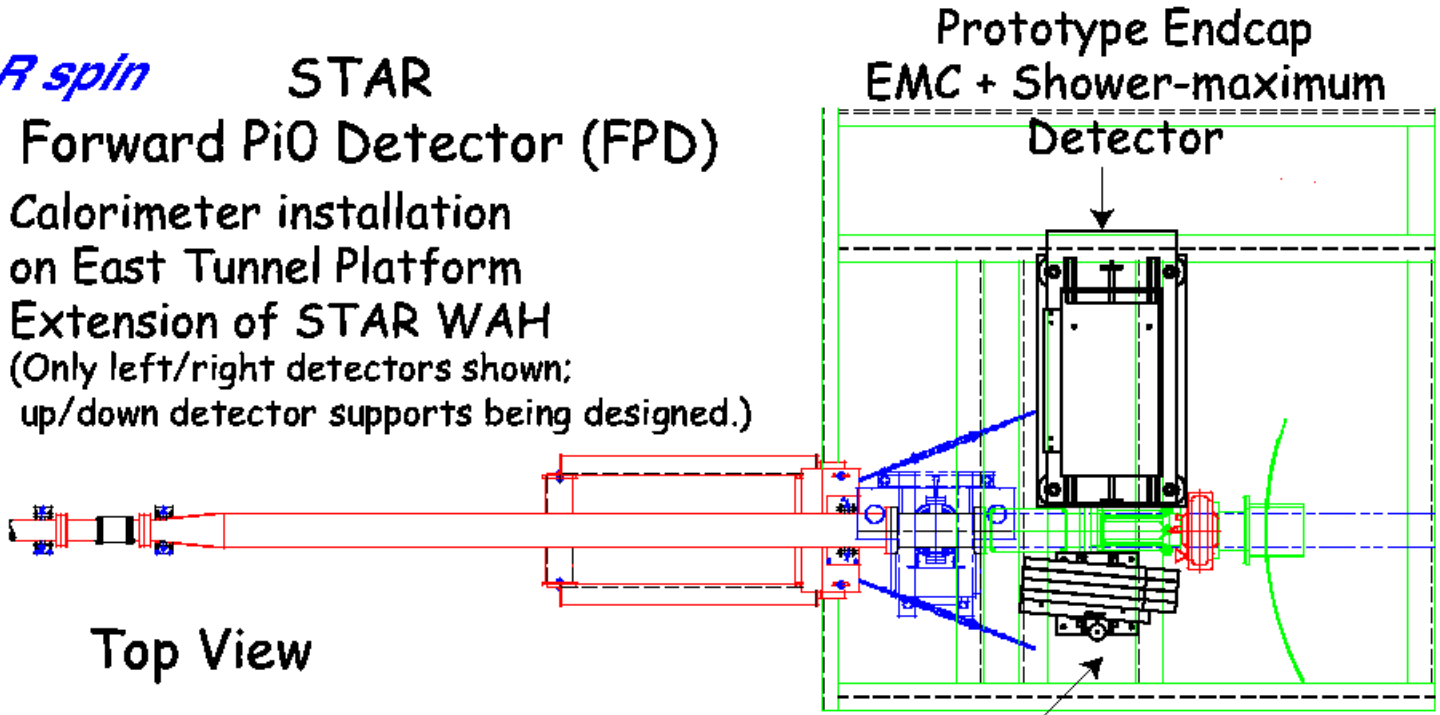
Safety Features:
Overcurrent protection from LeCroy 4032 high-voltage chassis and from HVSys Cockcroft-Walton controller. Upon an overcurrent condition, the controllers shut off the high voltage to that channel.

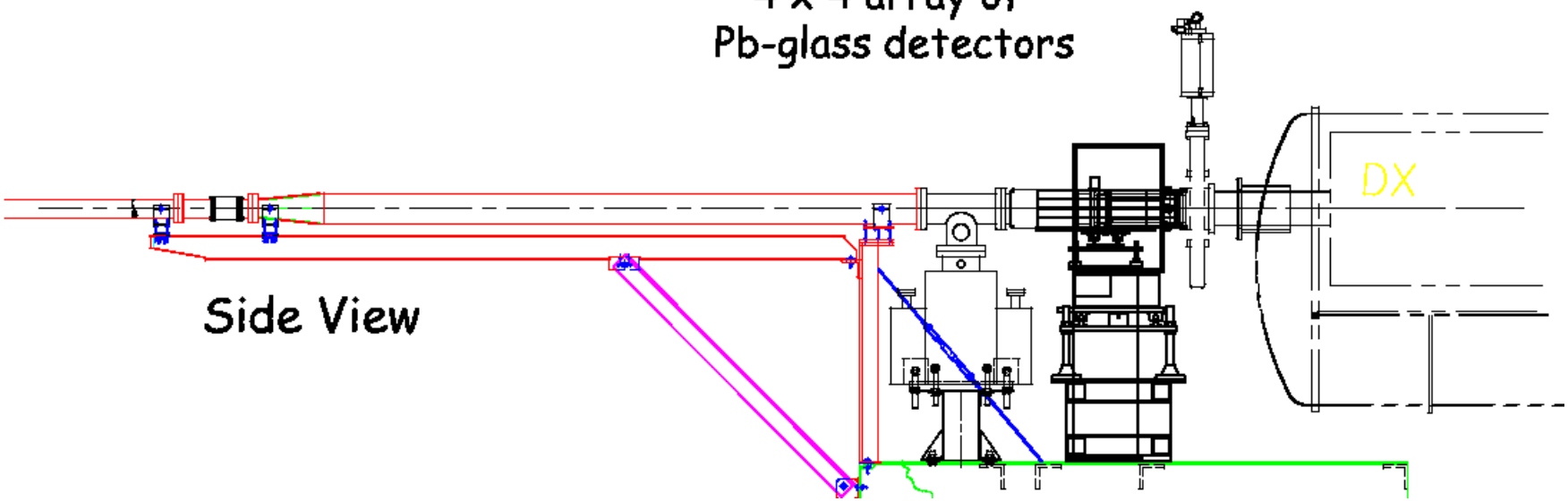
Procedures:
Under development.

STAR spin

STAR
Forward Pi0 Detector (FPD)

Calorimeter installation
on East Tunnel Platform
Extension of STAR WAH
(Only left/right detectors shown;
up/down detector supports being designed.)





Changes to SGIS Interlock System

- Two meetings have been held, and a few documents produced.
- Final schedule for changes still not clear, but Al P. and Dave P. plan to get done with SGIS work ASAP.
- New sub systems also coming online with detector based interlock systems.
- Concise, illustrated and tabbed SGIS response document still to be created.
- SGIS work must be completed, and “Blue Sheet” certification completed before we can introduce P10 into STAR.

OPMs, DWPs, and Detector Specific Procedures

C-A Operating Procedures Manual

These are high level procedures that mitigate certain hazards and recognize the need to communicate between the experiments and the C-A Department personnel whether those are MCR operations or CAS operations.

Local Emergency Procedure (C-A OPM 3.17)
Procedure for Preparing the STAR Magnet for Operation (Stevens. RHIC OPM-Temp C-A OPM, May 15, 2000)
STAR Power Supply Operating Procedure (Stevens, RHIC OPM-Temp C-A OPM, May 15, 2000)
Procedure for Exciting the STAR Magnet (Stevens, RHIC OPM-Temp C-A OPM, May 15, 2000)
Procedure for Bypassing the STAR Safety System (Christe, Draft, May 15, 2000)
Procedure to Start Filling the STAR with Flammable Gases (Christie, C-A OPM in review, May 15, 2000)
Procedure to Turn on the STAR High Voltages (Christie, Draft, May 31, 2000)

OPMs, DWPs, and Detector Specific Procedures

Documented Work Procedures

These procedures tend to be subsystem specific and are reviewed by the detector groups as well as C-A Safety. They are signed by the detector subsystem manager, the detector cognizant engineer, detector safety officer, the Liaison Physicist or Liaison Engineer. These procedures are tracked by the respective detector groups. The ESRC will review the status of these procedures on an annual basis or prior to the start of a running period.

TPC STAR Documented Work Procedures

SOP-TPC-HV-01-A *Operating the STAR TPC with a Lecroy 1458 HV Supply.*
SOP-TPC-HV-02-A *Operating the STAR TPC Field Cage.*
SOP-TPC-HV-03-A *Operating the STAR TPC Gated Grid System.*
SOP-TPC-GAS-05-A *Operating the STAR TPC Insulating Gap Gas System. Rev. 0.*
SOP-TPC-GAS-06-A *Allen Bradley Interlock System for the STAR TPC Gas System.*
6.10.1.3 *Operating the STAR TPC Gas System with P10 Gas. Rev. 1*
In the process of being updated to SOP-TPC-GAS-03-A
6.10.1.4 Nitrogen Purge and Shutdown of the STAR TPC gas after P-10 Operations. Rev. 1.
In the process of being updated to SOP-TPC-GAS-04-A
6.10.1.2, - *Starting the STAR TPC Gas System and Purging with Dry Nitrogen. Rev. 3.*
To be converted to SOP-TPC-GAS-02-A by May 31, 2000.
6.1.10.9 *Installing and Testing Front End Electronics in the STAR TPC. Rev. 3.*
To be converted to SOP-ELE-FEE-01-A by May 31, 2000.
6.10.1.6 *Operating the STAR TPC Laser Calibration System.*
To be converted to SOP-TPC-LASER-01-A by May 31, 2000.

Magnet Procedures:

SOP-MAG-GEN-01-B *Running the STAR Magnet in the Wide Angle Hall to Commission the Power Supplies*.

OPMs, DWPs, and Detector Specific Procedures

Installation & Test Procedures:

SOP-I&T-GEN-02-A *Documented Work Procedure for Utility Disconnects prior to STAR main hydraulic system operation.*

SOP-I&T-GEN-03-A *Documented Work Procedure for Utility Connections of the STAR Detector in the WAH/AB*

SOP-I&T-GEN-04-A *Documented Work Procedure for Mechanical Installation of Barrel EMC modules into the STAR Detector.*

Hydraulics Systems Procedures:

RHIC OPM 6.10.1.2 *STAR Detector Main Hydraulic System*
To be converted to a STAR DWP by July 1, 2000.

RHIC OPM 6.10.1.3 *STAR Detector Pole Tip Support Carriage Hydraulic System.*
To be converted to a STAR DWP by July 1, 2000.

RICH Detector Procedures:

SOP-RICH-GAS-01-A *Documented Work Procedure for the Startup and Operation of the STAR RICH Gas.*

SRP-RICH-INST-01-A *Documented Work Procedure for mechanical installation oof RICH counter into the STAR Detector in the STAR Assembly Hall.*

SVT Procedures:

SMP-SVT-I&R-01-B *Documented Work Procedure for Installation of the SVT Support cone assembly into STAR.*

Summary

Still Pending:

- Update STAR "Skill of the Craft Document".

Pass off to P. Cirnigliaro

- Develop additional Detector Specific Procedures for operation of new Sub Systems

- Get SGIS and Interlock updates done and certified

- Generate Environmental Emissions Document

Pass off to P. Lange